NOTES ON THE DIET OF *VARANUS GOULDII* IN A SEMI-URBAN ENVIRONMENT

By G.G. THOMPSON.
Edith Cowan University, Joondalup Drive, Joondalup, W.A., 6027.

INTRODUCTION

Varanus gouldii is a medium-sized monitor that is widely distributed throughout the Australian mainland (Cogger 1992) and is occasionally found in urban situations (Storr 1980). Shine (1986) and Pianka (1970, 1986, 1994) report the largest proportion by volume of *V. gouldii* diet to consist of lizards and mammals, whereas Pengilley (1981) reports *V. gouldii* eating a high proportion of invertebrates.

This paper reports on the stomach contents of *V. gouldii* caught in a section of Karrakatta Cemetery in the metropolitan area of Perth, and compares these data with those of Pianka (1982) and Shine (1986).

MATERIALS AND METHODS

Stomach contents of the 57 live *V. gouldii* (178–515 g) from Karrakatta Cemetery (115°47'E, 31°55'S) were obtained by flushing, using a technique similar to that reported by Legler and Sullivan (1979) between 19 October and 19 November 1990, and 17 October and 30 December 1992. Of the twenty *V. gouldii* caught during 1990, seven were recaptures and of the 37 caught in 1992, fifteen were recaptures. Gut contents were stored in a 10% solution of methanol.

The vegetation of Karrakatta Cemetery includes peppermint gums, callistemons, box gums, camphor-laurels, ghost gums, wandoos, flooded gums and jacarandas. Leaf litter has been allowed to accumulate in some areas around the graves. In the adjacent nature reserve there was a substantial ground cover of indigenous and non-indigenous grasses and leaf litter. *V. gouldii* have been observed to forage in the leaf litter between grave covers, under trees and shrubs and under grave covers (Thompson, *in press*).

RESULTS

Of the 57 stomachs flushed, only 46 yielded material able to be identified, either because of its size or degree of digestion (Table 1). The mole cricket (*Gryllotalpidae sp.*; 93 individual specimens) was the main food source of those *V. gouldii* captured, with 65 complete or near complete bodies and a further 28 head capsules being identified. The next most predominant food sources were spiders and larvae. A smaller number of centipedes, lizards, beetles and roaches were also identified in the gut contents.

Although it is not possible to statistically determine if there was a significant difference between the stomach contents of *V. gouldii* collected in northern Australia (Shine 1986), in central inland Western Australia (Pianka 1982) and Karrakatta Cemetery, a perusal of Table 1 would suggest that there was a difference. The *V. gouldii* reported by Pianka (1982) have a higher proportion of reptiles and reptile eggs compared with those at Karrakatta Cemetery and probably those in northern Australia. A relatively large number of beetles and grasshoppers are evident in both Shine's (1986) and Pianka's (1982) samples compared with those from Karrakatta Cemetery. The northern Australian *V. gouldii* have a relatively large number of unidentified invertebrate larvae in their stomach.

DISCUSSION

Pianka (1970, 1982, 1994) and Shine (1986) examined the gut contents of *V. gouldii* found in two different parts of Australia (arid deserts and northern tropics) and report the largest proportion, by volume, of their diet consisted of lizards and mammals. A considerable portion of the remainder was invertebrate material. Berney (1936) reports *V. gouldii* eating five newly laid 'fowl' eggs without breaking a single egg. Numerous *V. gouldii* (and *V. panoptes*) along the road verge from Paynes Find to Sandstone, in Western Australia, have been observed eating carrion, a finding similar to that of Bennett (1992) for *V. panoptes*. In contrast, Pengilley (1981) found the diet of *V. gouldii* on the Barkly Tablelands, Northern Territory, to consist of a high proportion of invertebrates, the majority being mole crickets which is similar to that found in the gut contents of *V. gouldii* at Karrakatta Cemetery.

The *V. gouldii* at the cemetery were often observed from a distance moving slowly and steadily through leaf litter using their snout to turn and move the ground flora, obviously searching for food. There was no evidence to suggest *V. gouldii* in Karrakatta Cemetery fed on any of the available larger vertebrate prey other than rats and perhaps the rainbow bee-eater or its eggs. On one occasion late in December 1993, a rat (*Rattus rattus*) was found that appeared to have been recently regurgitated, presumably by a *V. gouldii*, as this was the only spoor in the sand in the vicinity. Two rainbow bee-eater (*Merops ornatus*) ground-nests were found to have been partially dug up by what appeared to be a large *V. gouldii*, based on the spoor in the area. Other potential prey included smaller *V. gouldii*, of which only seven with a body mass less than 50 g have been seen between October 1990 and January 1994 and tree-nesting birds (parrots and the redwattle birds). One *V. gouldii* stomach contained rabbit (*Oryctolagus cuniculus*) hair, but there was no other evidence in its gut contents to suggest that the lizard had actually eaten parts of a rabbit. As there were a number of rabbits living under the grave coverings it is thought that this lizard had picked up the hair in its foraging.

V. gouldii has not previously been recorded as eating gastropods, but

Table 1. The number of recognisable food items in the stomachs of *V. gouldii*

	Karrakatta Cemetery	Pianka 1982	Shine 1986
No specimens examined	57	86	30
No without scat or stomach contents	11	23	
PREY TYPE			
INVERTEBRATES			
Scolopendrida (centipedes)	5	8	
Araneae (spiders)	10	15	11
Scorpionida (scorpions)		9	11
Hymenoptera (wasps)		1	5
Orthoptera (grasshoppers)	95	28	52
Blattodea (cockroaches)	4	10	
Phasmatodea (phasmids)		1	
Coleoptera (beetles)	4	48	41
Lepidptera (moths)	3	2	
Larvae	8	11	175
Dermaptera (earwig)	1		
Hemiptera (bugs)			1
(snails)	2		
(crabs)			1
Unidentified invertebrates		9	3
VERTEBRATES			
Lizards	5	38	12
Snakes			1
Reptile eggs	3	96	26
Frogs			7
Fish			3
Birds		2	
Mammals		1	3
Unidentified vertebrates		6	

the diets *V. olivaceus, V. niloticus, V. griseus,* and *V. salvator* have been reported to contain snails (Auffenberg 1988; Lonnberg 1903 in Losos and Greene 1988; Stanner and Mendelssohn 1986/87; Gaulke 1991). If molluscs are eaten regularly, then they could provide a significant proportion of the diet for *V. gouldii* in Karrakatta Cemetery due to their abundance and in the southern coastal plains of Western Australia where they are also readily available in many areas. The stomach contents of *V. gouldii* probably reflect a greater abundance of invertebrate prey compared with vertebrate prey items.

The feeding behaviour of *V. gouldii* at Karrakatta Cemetery was, as concluded by Shine (1986), Losos and Greene (1988) and James *et al.* (1992) for most varanids, an opportunistic one that exploits

whatever local food sources are available. Varanids have prodigious stomach capacities relative to their body size, enabling them to devour large items of prey when available. For example, an 11 g *V. caudolineatus* in captivity was seen to subdue and devour a 4 g gecko, a prey greater than one third of its body mass and Fleay (1950) reported a 20.4 kg *V. varius* regurgitating four fox cubs, three young rabbits and three large blue tongued lizards.

Jaw size of a varanid appears to determine the maximum size of prey able to be swallowed whole (Loop 1974: Pianka 1994: *pers. obs.*). Large bodied varanids will tend to eat prey that are both absolutely and proportionally larger (Losos and Greene 1988) and most probably vertebrates (Auffenberg 1981; Weavers 1989). The limiting factors in what many varanids eat appears to be what the lizard is able to locate, subdue and devour. It may be more efficient for large varanids to capture a small number of relatively large prey items; however, if large prey are not abundant as was the situation at Karrakatta Cemetery, then these *V. gouldii* and probably most other medium-sized varanids survive on a large number of much smaller items (Pengilley 1981). This study confirms the point of both Losos and Greene (1988) and Gaulke (1991) that there is often a lack of correlation between varanid food size and body size (mass).

Pough (1973) stated that insectivory was not an energetically feasible alternative for lizards with a mass greater than 300 g. Many of the *V. gouldii* from which stomach contents were flushed had a body mass greater than 300 g, indicating that these data, along with similar dietary information for *V. exanthematicus* (Cisse 1972) and *V. gouldii* (Pengilley 1981) do not support the hypothesis of Pough (1973).

From mid-October, '  ' shaped holes, with the top of the hole abutting a spider's hole, were often seen in the areas foraged by these lizards at Karrakatta Cemetery. Similar shaped holes have previously been found in the red-loamy soil of Atley Station, Western Australia, where *V. gouldii* have been observed excavating spiders from their holes. It is presumed that *V. gouldii* have dug these holes at Karrakatta Cemetery searching for invertebrate prey.

CONCLUSION

My data provides further support for the views of Shine (1986), Losos and Greene (1988), Thompson and King (1995) that the diets of varanids vary significantly with locality, and time of the year. Many varanids from Australian desert habitats feed predominantly on lizards (e.g., *V. eremius, V. gouldii, V. tristis*, Pianka 1986, 1994), which reflects the diversity and abundance of lizards in these localities (Pianka 1986; Morton and James 1988), and as would be expected, semi-aquatic varanids' (*V. semiremex, V. mitchelli, V. mertensi*) diets contain predominantly aquatic prey (Shine 1986; James *et al.* 1992). King *et al.* (1989) report *V. giganteus* on Barrow Island feed mainly on turtle eggs and hatchlings, and small-to-medium sized mammals, whereas James *et al.* (1992) report the stomach contents of six *V. giganteus* from museum collections to contain

mainly lizards, orthopterans, chilopods and mammals. It would be inap-propriate to draw conclusions about the diet, and the derived ecological information, for a varanid at a particular location from museum specimens unless they came from the same location.

ACKNOWLEDGEMENTS

Mr. Holman, Manager of Operations, approved access to Karrakatta Cemetery. The assistance of Mr. B. Poor and his staff in initially locating *V. gouldii* in the Cemetery was very much appreciated. The comments of P.C. Withers on an early draft of this paper and the assistance of W. and S. Thompson in locating and catching varanids was appreciated.

All lizards were caught under licence issued by the Department of Conservation and Land Management. Animal experimentation was done with the approval of the Animal Welfare Committee of the University of Western Australia.

REFERENCES

AUFFENBERG, W. 1981. *The Behavioral Ecology of the Komodo Monitor*. Uni. Presses of Florida, Gainesville.

AUFFENBERG, W. 1988. *Gray's Monitor Lizard*. Uni. Presses Florida: Gainesville.

BENNETT, D. 1994. A note on *Varanus panoptes rubidus* (Storr 1980) in Wanjarri, Western Australia. *British Herpetological Society Bulletin*, 39: 28–30

BERNEY, F.L. 1936. Gould's Monitor (*Varanus gouldiae*) *Queensland Naturalist*, Sept: 12–14.

CISSE, M. 1972. L'alimentation de Varanides au Senegal. *Bulletin de l'Institut Francais d' Afrique Noire, Serie* A. 34:503–515.

COGGER, H.G. 1992. *Reptiles and Amphibians of Australia*, Reed Books, N.S.W.

FLEAY, D. 1950. Goannas: Giant lizards of the Australian bush. *Animal Kingdom*, 53(3): 92–96.

GAULKE, M. 1991. On the Diet of the Water Monitor, *Varanus salvator*, in the Philippines. *Mertensiella*, 2: 143–153.

JAMES, C.D., LOSOS, J.B. and KING, D.R. 1992. Reproductive biology and diets of goannas (Reptilia: Varanidae) from Australia. *J. Herpetology*, 26:128–136.

KING, D. and GREEN, B. 1979. Notes on diet and reproduction of the sand goanna, *Varanus gouldii rosenbergi*. *Copeia* 1979(1): 64–70.

KING, D. GREEN, D. and BUTLER, H. 1989. The activity pattern, temperature regulation and diet of *Varanus giganteus* on Barrow Island, Western Australia. *Aust. Wildl. Res.* 16:41–47.

LEGLER, J.M. and SULLIVAN, L.J. 1979. The Application of Stomach-Flushing to Lizards and Anurans. *Herpetologica* 35(2): 107–110.

LOOP, M.S. 1974. The effects of relative prey size on the ingestion behaviour of the Bengal monitor *Varanus bengalensis* (Sauria: Varanidae). *Herpetologica*, 30: 123–127.

LOSOS, J.B. and GREENE, H.W. 1988.

Ecological and evolutionary implications of diet in monitor lizards. *Biol. J. Linn. Soc. (Lond).* 35: 379–407.

MORTON, S.R. and JAMES. C.D. 1988, The diversity and abundance of lizards in arid Australia: a new hypothesis. *Amer. Natur.* 132: 237–256.

PENGILLEY, R. 1981. Notes on the Biology of *Varanus spenceri* and *V. gouldii*, Barkly Tablelands, Northern Territory. *Aust. J. Herp.* 1(1): 23–26.

PIANKA, E.R. 1970. Notes on the Biology of *Varanus gouldii flavirufus*. *West. Aust. Nat.* 11: 141–144.

PIANKA, E.R. 1982. Observations on the ecology of *Varanus* in the Great Victoria Desert. *West. Aust. Nat.* 15: 1–8.

PIANKA, E.R. 1986. *Ecology and Natural History of Desert Lizards.* Princeton Uni. Press, New Jersey.

PIANKA. E.R. 1994 Comparative Ecology of *Varanus* in the Great Victoria Desert. *Aust. J. Zool.* 19: 21–34.

POUGH, F.H. 1973. Lizard energetics and diet. *Ecology*, 54: 837–844

SHINE, R. 1986. Food Habits, Habitats and Reproductive Biology of Four Sympatric Species of Varanid Lizards in Tropical Australia. *Herpetologica* 42(3): 346–360.

STANNER, M. and MENDELSSOHN, H. 1986/87. The diet of *Varanus griseus* in the southern coastal plain of Israel (Reptilia: Sauria). *Israel J. Zool.* 34: 67–75.

STORR, G.M. 1980. The Monitor Lizards (Genus *Varanus* Merrem, 1820) of Western Australia. *Rec. West. Aust. Mus.* 8(2):237–293.

THOMPSON, G.G. (*in press*) Foraging patterns and behaviours, body postures and movement speed for goannas, *Varanus gouldii* (Reptilia: Varanidae), in a semi-urban environment. *Journal of the Royal Society of Western Australia.*

THOMPSON, G.G. and KING. D. (1995). Diet of *Varanus caudolineatus* (Reptilia: Varanidae). *West. Aust. Nat.* 20: 199–204.